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AUTHOR Sarapin, Marvin I.
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ABSTRACT

A review of the rationale and application of formative evaluation in a curriculum development context, this presentation focused on a formative evaluation model designed and field tested through recent industrial education curriculum research and development efforts. In reviewing the rationale for formative evaluation a distinction between formative and summative evaluation was made, and a role dimension matrix for formative and summative evaluation was provided to distinguish each in dimensions of time, audience, and purpose. In the formative evaluation conceptual model the following four phases of educational product development and evaluation were specified: (1) identify and order goals, (2) identify and operationalize objectives, (3) develop interim materials, and (4) field test products. (Within each phase were incorporated a specific developmental activity, an evaluation component, and feedback input.) Finally, in a discussion of the model it was concluded that formative evaluation is generalizable to other curriculums, but that the specific terminology, techniques, and procedures of the model presented should be considered individually for each situational application. (VB)

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FORMATIVE EVALUATION: A MODEL FOR INSTRUCTIONAL MATERIAL DEVELOPMENT AND REVISION IN INDUSTRIAL ARTS EDUCATION.

Marvin I. Sarapin, assistant professor, Department of Industrial Education, University of Maryland, College Park, MD.

Introduction

The systematic development, revision, and assessment of instructional materials and processes are perennial concerns of educators involved in the curriculum development process. Within the discipline of industrial arts education, continual efforts to improve instructional programs have materialized during the last two decades. Research and development have facilitated changes in the definition of the field, the curriculum base, the educational goals and objectives, and the teaching learning strategies employed by public school industrial arts teachers.

Alternative instructional content and teaching strategies have been delineated by individuals and groups of individuals seeking to revise and improve public school industrial arts programs. New state-wide curriculum guides have been developed in Hawaii, Iowa, Kansas, Maryland, Minnesota, Virginia, Wisconsin, and other states. However, as one curriculum development committee observed:

> Regardless of the process used for curriculum development, no curriculum is ever perfect, nor complete, nor can it remain static. Weak points and inconsistencies will continuously arise in even the most carefully developed program .... The

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> individual teachers, curriculum committees, and administrators should therefore strive to continuously evaluate and refine the industrial arts curriculum.
> (The Iowa Guide for Curriculum Improvement in Industrial Arts, K-12, 1975, p.8)

In the process of curriculum revision and improvement, an array of methods is available to assist the curriculum developer identify the source and scope of content for specific instructional programs. Occupational analysis, content analysis, and concept analysis procedures are adequately developed and reported to assist the curriculum developer identify the universe of content from which instructional materials may ultimately be derived. However, methods and procedures for monitoring the instructional material development and improvement process and for utilizing assessment and revision feedback have not been as adequately developed or reported.

One particular strategy for guiding and monitoring curriculum efforts within the instructional material development-assessment-revision continuum is formative evaluation. The objective of this presentation is to review the rationale and application of formative evaluation in a curriculum development context. A formative evaluation model designed and field tested through recent industrial education curriculum R&D efforts will be presented and discussed.

A Concept of Evaluation

Evaluation is a topic many educators find uncomfortable, confusing, and threatening. In part, these negative attitudes toward the process of evaluation can be attributed to a lack of understanding of the characteristics of educational evaluation. Insight concerning the characteristics of evaluation can be obtained by examining the context of evaluation from examples in the world around us.

Evaluation is part of the decision-making process used daily in almost every aspect of society. Citizens utilize an evaluative process by judging the relative effectiveness of elected representative government and by making decisions in future election campaigns. Industries evaluate their materials, processes, personnel, and products to provide data for decision making. Employers judge the worth and merit of employees and make decisions concerning salary adjustments, promotions, and job terminations. At home, people evaluate their lifestyles and make decisions to continue, modify, or terminate specific family behaviors. In the schools, we evaluate students, teachers, administrators, staffs, curricula, programs, procedures, budgets, and other interactive components to maintain and improve the educational enterprise.

Extracting clues from the preceding scenario concerning the characteristics of evaluation reveals that evaluation is a multifaceted endeavor. However, in the examples above, two central characteristics were apparent. Evaluation involves judgment of worth and merit and evaluation is related to the decision-making

process. These elements can be synthesized forming a definition for the process of educational evaluation. That is, educational evaluation is an activity which involves ascertaining the worth and merit of educational processes and products to supply information for decision making.

Formative and Summative Evaluation

The goal of educational evaluation activities derived from the preceding definition is not intended to be confusing or threatening to the educator. The goal of educational evaluation is simply to ascertain the worth and merit of educational entities to supply information for decision making. However, the uses of evaluation procedures are varied in different educational settings. Cronbach (1963) identified that evaluation can be used in three different situations: A) course improvement, B) decisions about individuals, and C) administrative regulation. In the development of the model presented here and in the application of evaluation procedures by curriculum developers, evaluation for course improvement is paramount.

Evaluation methodology has two roles in the course improvement process. The first role is to judge the worth and merit of prototype instructional materials, processes, and products to supply decision-making data concerning needed revision. The second role is to assess finished processes and products to facilitate decisions concerning dissemination and diffusion. Cronbach (1963) has pointed out:

> The greatest service evaluation can perform is to identify aspects of the course where revision is desirable....Evaluation, used to improve the course while it is fluid, contributes more to the improvement of education than evaluation used to appraise a product already placed on the market. (p. 679)

According to Scriven (1967) the two roles of evaluation in the course improvement procedure may be called formative and summative evaluation. The key differences in these applications of evaluation (Figure 1) are the former applies to processes and products under development and the latter applies to finished processes and products.

Place Figure 1 about here

An operational definition of formative evaluation was given by Cunningham (1972) as follows:

> Formative evaluation (is) the gathering of information which would be of use to the developers of instructional materials, those persons who are trying to choose or produce the parts, the elements which will combine to form the successful whole. Information of concern to developers is usually that which will help them determine the success of their initial efforts, so that modifications can be made. (p. 111)

Formative evaluation incorporates the collection and use of feedback data to developers of educational processes and products. The purpose of these activities is to facilitate further assessment, revision, and improvement of instructional materials and other educational components during the formative period of development.

Role	Dimension		
	Time	Audience	Purpose
Formative	Formative period	Author developer	Instrument revision and improvement
Summative	Summative period	Consumer user	Instrument dissemination and diffusion

Figure 1. Role-dimension matrix in formative and summative evaluation.

In contrast to formative evaluation, summative evaluation represents a somewhat different evaluation role. Cunningham (1972) presented the essence of summative evaluation as follows:

> The term "summative evaluation," often used as a point of contrast with "formative evaluation," would refer to the collection of information of use to the consumer of the instructional materials, those who seek to determine what they are getting for their money, what they can expect from the product, whether the product is better than others, and so forth. Information of use to developers will sometimes, but not necessarily, overlap with information of use to consumers and vice versa. (p. 112)

Summative evaluation incorporates the collection and utilization of evaluation data after the educational process or product is completed. The feedback data in summative evaluation is intended to be used by the consumer, the user of the educational process or product. The purpose of summative evaluation activities is to facilitate decisions concerning the ultimate dissemination, adaption, and diffusion of the educational entity under consideration.

Developers of instructional materials including textbooks, learning activity packages, programmed instruction, and individual modules and activities need feedback information during the formative period of development to facilitate the assessment, improvement, and revision of subsequent versions of the developmental products. According to Baker and Alkin (1973):

> Substantial amounts of funds are wasted each year on the purchase and installation of educational products that later prove to be inappropriate or ineffective. To prevent such economic and educational waste and the negative effects it could have on the further acceptance and use of educational products, and at the same time, to improve the products ultimately produced, developers should engage to a greater extent in formative evaluation of all products. Formative evaluation data would provide information to developers that would allow them to modify and improve their products before they are distributed. (p. 389)

Collecting and using formative evaluation data as feedback to curriculum developers is the key in guiding and monitoring the instructional material development, revision, and assessment process. Grobman (1971) has added:

> The most immediate evaluation need of the developmental curriculum process (is) the feedback of information on preliminary materials during the process of material preparation, to determine the general feasibility and to obtain clues concerning needed change. (p. 439)

Formative evaluation represents an evaluation strategy for collecting and using data concerning the worth and merit of instructional processes and products to supply information for decision making during the formative period of instructional material development. The application of formative evaluation procedures can facilitate instructional material development, assessment, and revision.

The Formative Evaluation Model

The formative evaluation model presented in Figure 2 is similar in content to the evaluation "framework" reported by Sanders and Cunningham (1973, p.217). However, in this presentation a symbolic model is used to help visualize and simplify the components essential to formative evaluation of developmental instructional materials.

Four phases of educational product development and evaluation are identified in the formative evaluation conceptual model. Each phase is represented by a rectangle with a verbal description and a point-numeric code in the lower right-hand corner. Within each phase of the model, three components are represented. Each phase of the formative evaluation model incorporates a specific developmental activity, an evaluation component, and feedback input.

Place Figure 2 about here

Specified in the model are four developmental activities: (1) identifying and ordering goals, (2) identifying and operationalizing objectives which reflect the priority goals, (3) developing interim instructional materials to implement the goals and objectives, and (4) field testing the developmental materials to determine if finished products have emerged from the developmental process.

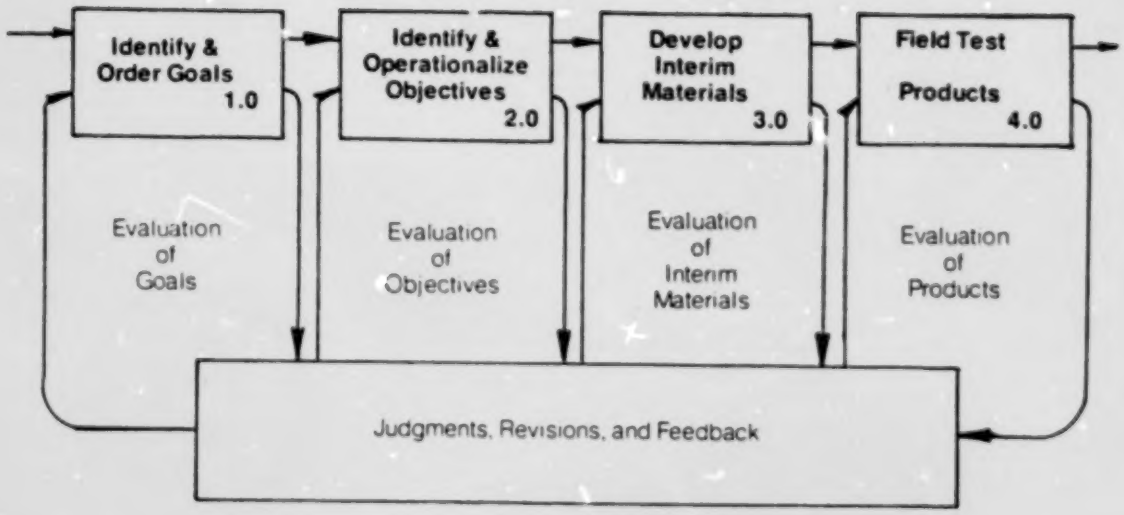

Figure 2. The formative evaluation conceptual model.

Suggested in the model are four different functions of evaluation: (1) assessment of the worth and merit of the identified goals, (2) assessment of the objectives for worth and merit and congruence with identified goals, (3) assessment of the interim materials for content and procedural validity in light of the identified goals and objectives, and (4) assessment of the emerging educational products as applied in the classroom and learning laboratory. In each phase of the model decision making based on evaluation data provides feedback input concerning the need to adopt, revise, or terminate development of the process or product.

Application of Formative Evaluation

The formative evaluation conceptual model was designed and tested (Sarapin, 1977) using the curriculum development efforts of an industrial arts curriculum institute conducted by Iowa State University, Department of Industrial Education during the summer sessions of 1976 and 1977 and the 1976-77 school year. Institute participants identified, developed, tested, and revised exemplary learning activities in exploratory graphic communications to implement the rationale of The Iowa Guide for Curriculum Improvement in Industrial Arts, K-12 (1975). The formative evaluation model was implemented using the activities and events represented in the flowchart presented in Figure 3. In the formative evaluation flowchart, diamond shapes represent curriculum development decisions, six-sided polygons

communicate developmental activities, and oval shapes simulate evaluation inputs.

Phase (1.0): Identify and order goals

The developmental, evaluative, and decision-making activities in Phase (1.0) of the formative evaluation model provided the basis for establishing developmental priorities. Needs assessment activities of an advisory committee (n=9) comprised of industrial arts teachers, teacher educators, state department of education consultants, local administrators, and subject matter experts served decision making (symbol 1.1) for needed curriculum development.

A team of industrial arts teachers (n=10) was organized for participation in a curriculum development institute. Participants, working with a subject matter expert, identified general goal statements (symbol 1.2) giving direction to subsequent curriculum development efforts. Identified goals were arranged in tentative priority order (symbol 1.3) and evaluated (symbol 1.4) by the institute participants and the advisory committee using a Likert-type instrument.

Data produced served decision making (symbol 1.5) concerning the need to revise or adopt priority goals. As a result of completing the first phase of the formative evaluation model, a rank-ordered listing of priority goals emerged from the curriculum development process.

Place Figure 3 about here

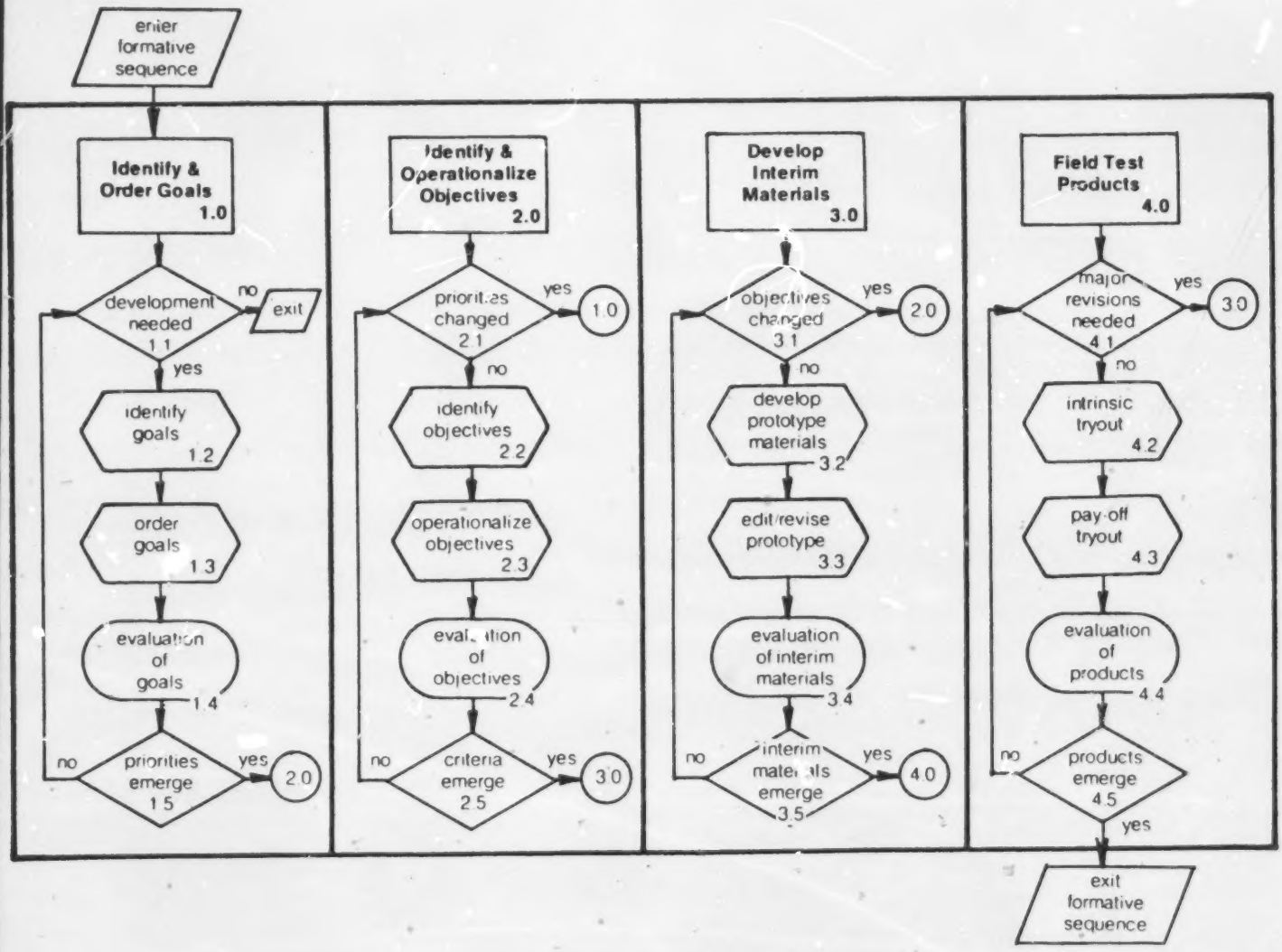

Figure 3. The formative evaluation flowchart.

Phase (2.0): Identify and operationalize objectives

Activities and procedures in Phase (2.0) of the model facilitated development and assessment of criteria for the instructional material development process. Previously identified priority goal statements were reviewed (symbol 2.1) by the institute participants and delineated further forming instructional objectives (symbol 2.2). A technical content taxonomy was developed to serve as a conceptual tool in the initial organization of priority goals and objectives (symbol 2.3).

Institute participants and advisory committee members evaluated (symbol 2.4) the worth and merit of identified objectives and the goal/objective congruence using a Likert-type instrument. Data produced enabled decision making (symbol 2.5) concerning the need to revise and redevelop objectives or advance to the next phase of curriculum development. As a result of completing phase (2.0) criteria emerged for subsequent instructional material development.

Phase (3.0): Develop interim materials

Phase (3.0) of the formative evaluation model facilitated the development and assessment of prototype instructional materials. After reviewing prior developed objectives (symbol 3.1) instructional modules were developed (symbol 3.2) by writing teams of industrial arts teachers attending a curriculum development institute. Professional judgments of a subject matter expert and the writing teams facilitated the editing and revision

(symbol 3.3) of the instructional materials. The developed instructional materials were evaluated (symbol 3.4) by a panel of practicing teachers using a Likert-type instrument. Data produced facilitated decision making (symbol 3.5) concerning the need for instructional material revision prior to field testing in public school classrooms and laboratories. As a result of completing the activities in this phase of the model instructional materials were identified for revision and others were identified for field testing.

Phase (4.0): Field test products

The activities and procedures in phase (4.0) of the model facilitated the tryout and evaluation of instructional materials in public school classrooms and learning laboratories. The initial symbol (4.1) represented a conceptual linkage to previous developmental activities. Participating teachers conducted intrinsic review (symbol 4.2) of the newly developed instructional modules. Specifically, review criteria centered around the procedural barriers, strengths, and weaknesses of the field tested materials. Treatment and control classes were identified for instructional material tryout (symbol 4.3). Activities 4.2 and 4.3 represented developmental components because the field test materials were considered formative and could be revised in form and content.

Evaluation of the field test materials (symbol 4.4) was facilitated by administering student posttest and participating teacher questionnaires. Data collected facilitated decision making (symbol 4.5) concerning the need for revision or further

development and field testing of instructional materials. As a result of completing the field test portion of the model, instructional products emerged from the curriculum development sequence. Materials judged unworthy of large scale student use were recycled within the model. Materials meeting tryout criteria were judged to be finished products.

Discussion

The formative evaluation model was found to be a useful tool for monitoring and guiding the systematic development, revision, and assessment of instructional materials by industrial arts teachers participating in a curriculum development institute. The application of formative evaluation can be generalized to other curriculum undertakings where the systematic development, assessment, and revision of instructional components are desirable. In general, curriculum development and revision endeavors are similar in nature with respect to the four phases of the formative evaluation model presented. That is, most curriculum development projects will identify goals, identify objectives, develop interim materials, and test the materials in the classroom. The formative evaluation model can serve as the basis for predevelopment design in subsequent curriculum development and revision undertakings. However, the observations of Wenig (1974) should be considered:

> In the long run, it is better that each individual develop his own model with his own terminology and his own application techniques. When the individual has achieved this, he can begin to achieve the true significance of the total program evaluation models in assisting him to gather information that is necessary to make informed judgments. (p. 59)

Therefore, the specific terminology, techiques, and procedures of the model presented should be considered individually for each situational application.

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